Application No. 10/070,966
Applicant: Udo HOLKER
Amendment Dated January 22, 2004
Reply to Office Action of October 22, 2003

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-52 Cancelled.

53. A bioreactor for fermenting solid substrates, comprising a fermentation vessel, a charging means for bioreactive substances, and at least one nozzle arrangement within said fermentation vessel for aeration and thorough mixing of the substrates, wherein the at least one nozzle arrangement has a multitude of pipes extending in parallel into a reaction space of the fermentation vessel and provided with nozzles, wherein a first, vertically extending nozzle arrangement can be extended into and retracted from the reaction space of the fermentation vessel, and having a second, horizontal nozzle arrangement with at least one pipe having nozzle orifices and extending horizontally through the reaction space.

54. The bioreactor according to claim 53, wherein a second, horizontal nozzle arrangement is provided which consists of at least two interconnected pipes extending horizontally and in parallel through the reaction space, each having a plurality of nozzle orifices.

55. The bioreactor according to claim 53, wherein said horizontal nozzle arrangement can be rotated around a horizontal rotation axis.

56. The bioreactor according to claim 53, wherein said fermentation vessel has a bottom section with a tapering cross-section.

57. The bioreactor according to claim 56, wherein said bottom section is conically designed and leads into a draining channel which is inclined from horizontal and has a draining valve at the lowest position thereof.

58. The bioreactor according to claim 53, wherein said at least one nozzle arrangement receives compressed gas from a pressure vessel.

59. The bioreactor according to claim 58, wherein said pressure vessel contains a bioreactive liquid substance in addition to said compressed gas.

60. The bioreactor according to claim 59, wherein said at least one nozzle arrangement alternatively receives compressed air or said liquid bioreactive substance from said pressure vessel.

61. The bioreactor according to claim 53, wherein said at least one nozzle arrangement can be pressurized with pulsing compressed air.

62. The bioreactor according to claim 53, wherein said second nozzle arrangement is provided within said fermentation vessel in a height-adjustable manner.

63. The bioreactor according to claim 59, wherein a multitude of pressure vessels pressurized with compressed air and connected to a mixing vessel are provided which contain different liquid bioreactive substances.

64. The bioreactor according to claim 63, wherein said mixing vessel has a pressure compensating means.

65. The bioreactor according to claim 63, wherein said pressure vessels are exchangeable and can be separately autoclaved.

66. The bioreactor according to claim 57, wherein said draining channel is covered by a wire mesh.

67. The bioreactor according to claim 53, wherein a pressure lid of said fermentation vessel accommodates said first nozzle arrangement whose pipes extend vertically from the pressure lid into the reaction space.

68. The bioreactor according to claim 67, wherein said vertical pipes of said first nozzle arrangement are provided in said pressure lid to be exchangeable.

69. The bioreactor according to claim 53, wherein said fermentation vessel is connected through a feed line with a measuring chamber, which is again connected through a recirculating line with said fermentation vessel, and said measuring chamber can be pressurized for recirculating measured media.

70. The bioreactor according to claim 53, wherein a device for heat exchange is provided comprising a device:

(i) in which said fermentation vessel has a double wall and the thus formed cavity can be flowed through with temperature-controlled heat exchange fluids through a connecting pipe and discharge pipe; and/or

(ii) which is a horizontal pipe system within said fermentation vessel which can be flowed through with a temperature-controlled heat exchange fluid.

71. A method of producing a fermentation product, said method comprising the aerobic fermentation of a reaction medium comprising solid substrates to produce a fermentation product, and

the recovery of the fermentation product produced, wherein the reaction medium containing the solid substrates is thoroughly mixed by compressed gas supplied to the reaction medium from above.

72. The method according to claim 71, wherein said thorough mixing is effected by a continuous stream of compressed gas or by compressed gas pulses.

73. The method according to claim 71, wherein said solid substrates are selected from the group consisting of coal, wood and loaded soils.

74. The method according to claim 73, wherein said solid substrate is coal.

75. The method according to claim 74, wherein the solid substrate is brown coal (lignite).

76. The method according to claim 74, which further comprises adding a fermentable microorganism, nutrients and/or buffers to the reaction medium.

77. The method according to claim 75, wherein said brown coal or the reaction medium containing said brown coal is tyndallized together with a bioreactor prior to fermentation or prior to the addition of a microorganism.

78. The method according to claim 75, wherein:

(i) said brown coal has a particle size of from 1 to 10 mm;

(ii) a microorganism is added to the reaction medium, and the microorganism is selected from the group consisting of molds, yeasts and white rot fungi;

(iii) the pH of the reaction medium is from 5.5 to 6.0 at a beginning of the reaction;

(iv) the pH is maintained at from 6.5 to 7.2 during a solubilization phase;

(v) the fermentation is performed at a temperature of from 25 °C to 30 °C; and/or

(vi) from 1 to 25 liter of compressed air per liter of fermentation broth per day is passed through the reaction medium.

79. The method according to claim 78, wherein the microorganism added to the reaction medium is Trichoderma atroviride.

80. The method according to claim 71, wherein said fermentation is performed in a bioreactor comprising a fermentation vessel, a charging means for bioreactive substances, and at least one nozzle arrangement within said fermentation vessel for aeration and thorough mixing of the substrates, wherein the at least one nozzle arrangement has a multitude of pipes extending in parallel into a reaction space of the fermentation vessel and provided with nozzles, wherein a first, vertically extending nozzle arrangement can be extended into and retracted from the reaction space of the fermentation vessel, and having a second, horizontal nozzle arrangement with at least one pipe having nozzle orifices and extending horizontally through the reaction space.